Clinical Biomechanics 29 (2014) 815–821

Contents lists available at ScienceDirect

Clinical Biomechanics

journal homepage: www.elsevier.com/locate/clinbiomech

Three-dimensional scapular motion during arm elevation is altered in women with fibromyalgia

Mariana Arias Avila, Paula Rezende Camargo, Ivana Leão Ribeiro, Antonio Roberto Zamunér, Tania Fátima Salvini *

Department of Physical Therapy, Federal University of São Carlos, São Carlos, SP, Brazil

ARTICLE INFO

Article history:
Received 28 January 2014
Accepted 21 May 2014

Keywords:
Biomechanics
Fibromyalgia
Physical therapy
Shoulder

ABSTRACT

Background: The core feature of fibromyalgia is pain, which may play a role in various mechanisms that might lead to alterations in shoulder kinematics. Alterations in muscle activity and presence of tender points in the shoulder girdle have already been described in this population; however there is lack of evidence on three-dimensional scapular motion in women with fibromyalgia.

Methods: Forty women with fibromyalgia and 25 healthy women (control group) matched in terms of age, weight and height, took part in this study. Three-dimensional scapular kinematics of the dominant arm were collected during elevation and lowering of the arm in the sagittal and scapular planes. Pain was evaluated by the Visual Analogue Scale and the Numerical Pain Rating Scale. Group comparisons were performed with one-way ANOVA for pain and two-way ANOVA for the kinematic variables (scapular internal/external rotation, upward/downward rotation and anterior/posterior tilt), with group and humeral elevation angle as categorical factors. Significance level was set at $P < 0.05$.

Findings: Fibromyalgia women presented higher pain scores ($P < 0.001$) than the control group. Fibromyalgia women also presented greater scapular upward rotation ($P < 0.001$, both planes) and greater scapular posterior tilt ($P < 0.001$, both planes) than the control group.

Interpretation: Women with fibromyalgia present greater scapular upward rotation and posterior tilt in the resting position and during arm elevation and lowering of the arm in sagittal and scapular planes. These alterations may be a compensatory mechanism to reduce pain during arm movement.

1. Introduction

Fibromyalgia (FM) is a chronic non-inflammatory syndrome, in which diagnosis is basically clinical as there are no supplementary exams that identify it (Wolfe et al., 1990, 2010). The global prevalence of FM is 2.7%, based on 26 studies worldwide, and is more prevalent in women than in men (Queiroz, 2013). Although there are other common symptoms and comorbidities (e.g., non-restorative sleep, fatigue, morning stiffness), the core feature of FM is the widespread musculoskeletal pain (Wolfe et al., 1990). The American College of Rheumatology established, as the diagnostic criteria for FM, the widespread pain for more than 3 months, and at least 11 out of 18 active tender points, sensitive sites in which a digital pressure of 4 kg/cm^2 or less induces pain (Wolfe et al., 1990). Ten of these 18 points are located in the cervical and shoulder girdle regions (Mease, 2005).

Previous studies have shown that FM patients present altered muscular functions such as less oxygen extraction and longer oxygenation recovery following exercise and muscle ischemia (Shang et al., 2012), increased DNA fragmentation and changes in the number and size of mitochondria (Sprott et al., 2004), and unspecific alterations that might affect muscle microcirculation and lead to sensitization of the intramuscular nociceptors (Bengtsson, 2002). They also present reduced maximal exercise capacity (Bachasson et al., 2013), impaired postural control and low balance self-efficacy (Muto et al., 2014). These alterations might precede the physical deconditioning status inherent to the FM patients (Nielens et al., 2000; Panton et al., 2006) and affect their daily life.

Studies have already shown that FM patients present altered gait kinematics, with lower walking speed, stride length and cadency than healthy volunteers (Auvinet et al., 2006; Heredia-Jiménez et al., 2009), and higher metabolic demand to walk at a comfortable speed (Pierrynowski et al., 2005). However, no studies involving upper limb kinematics in FM patients have been found.

Considering that FM patients present several tender points in the cervical and shoulder girdle regions, along with alterations in activity of the trapezius muscle (Gerdle et al., 2010), scapular kinematics

* Corresponding author at: Department of Physical Therapy, Federal University of São Carlos, Rodovia Washington Luís, km 235, Monjolinho, PO Box 676, ZIP Code 13565-905 São Carlos, SP, Brazil.
E-mail address: tania@ufscar.br (T.F. Salvini).

http://dx.doi.org/10.1016/j.clinbiomech.2014.05.007
0268-0033/

might probably be altered in FM patients. Normal shoulder kinematics are vital to everyday activity performance (Roy et al., 2010), given that the shoulder is the reaching guide joint (Vandenberghe et al., 2010). Compromised shoulder movement can cause substantial disability and affect the person's ability to carry out work and daily activities such as eating, dressing, and personal hygiene (Mitchell et al., 2005). Abnormalities in scapular kinematics as well as altered muscle activation have been associated with shoulder pathologies (Ludewig and Reynolds, 2009; Phadke et al., 2009).

Due to the lack of studies that have evaluated shoulder biomechanics in women with FM, the aim of the present study was to characterize the 3D scapular motion during elevation and lowering of the arm in women with FM. The hypothesis is that women with FM show altered pattern of scapular motion relative to a control group.

2. Methods

This study was approved by the Ethics Committee of the University (protocol number 485/2011), and is registered at the ClinicalTrials.gov under the number NTC01839305. Patients gave their written and informed consent to participate in this study, which was conducted according to the Helsinki Statement.

2.1. Subjects

Two-hundred and fifty women were recruited to take part in the study. FM volunteers (n = 172) were recruited from local community after they responded to flyers posted in university buildings, orthopedic and rheumatologic clinics, or from our database of FM patients that enrolled to other studies. All of them had the FM diagnosis given by their doctors already. The control group (n = 78) was recruited from local community and through personal contacts of the investigators (Fig. 1).

The inclusion criteria for the FM group were: 1) to have a clinical fibromyalgia diagnosis according to the 1990 ACR criteria, which includes the examination of the 18 tender points; and 2) to be aged from 30 to 60 years old. The control group had to be age-, height- and weight-matched with the FM subjects, and report good health conditions. The exclusion criteria for both groups included: 1) Body Mass Index > 28 kg/m^2, as it could influence the accuracy of the kinematics; 2) Cognitive deficits that prevented volunteers to understand the evaluation procedures; 3) Uncontrolled systemic illnesses (e.g. diabetes mellitus and systemic arterial hypertension); 4) Neurological and musculoskeletal conditions that could have directly interfered in the evaluations, as paresis, important sensitive alterations, advanced joint diseases (e.g. arthroplasties or osteoarthritis); 5) Infections; 6) Urinary incontinence; and 7) Pregnancy.

2.2. Study design

All volunteers underwent the initial interview, in which the inclusion and exclusion criteria were evaluated, and those who fit the study were invited to participate. Those who agreed to take part answered the Fibromyalgia Impact Questionnaire (FIQ, only applied for the FM subjects), the Beck Depression Inventory (BDI) and the Visual Analogue Scale (VAS) for pain and fatigue at the moment of admission in the study. A week after this interview, subjects underwent the evaluation session, which comprised the three-dimensional (3D) scapular data collection, VAS and the Numerical Pain Rating Scale for pain in different situations.

2.3. Scapular kinematics data collection

3D motion data using the Flock of Birds® electromagnetic tracking system (Ascension Technology, Burlington, VT, USA) were collected and integrated with MotionMonitor software (Innovative Sports Training, Chicago, IL, USA), with a sampling rate of 100 Hz per sensor. In a metal free environment up to a distance of 76 cm from the transmitter the root mean square (RMS) accuracy of the system is 0.5° for orientation and 0.18 cm for position, as reported by the manufacturer.

Three surface sensors were attached with double-sided adhesive tape to the sternum and acromion and a thermoplastic cuff was secured to the distal humerus. The transmitter was onto a wooden rack directly behind the evaluated shoulder. Bony landmarks on the thorax, scapula and humerus were palpated and digitized with a stylus with known offsets to allow transformation of the sensor data to local anatomically based coordinate systems. Local coordinate systems were established for the trunk, clavicle, scapula and humerus using the digitized landmarks following the International Society of Biomechanics recommended protocol (Wu et al., 2005). The z-axis pointed laterally, the x-axis anteriorly and the y-axis superiorly.

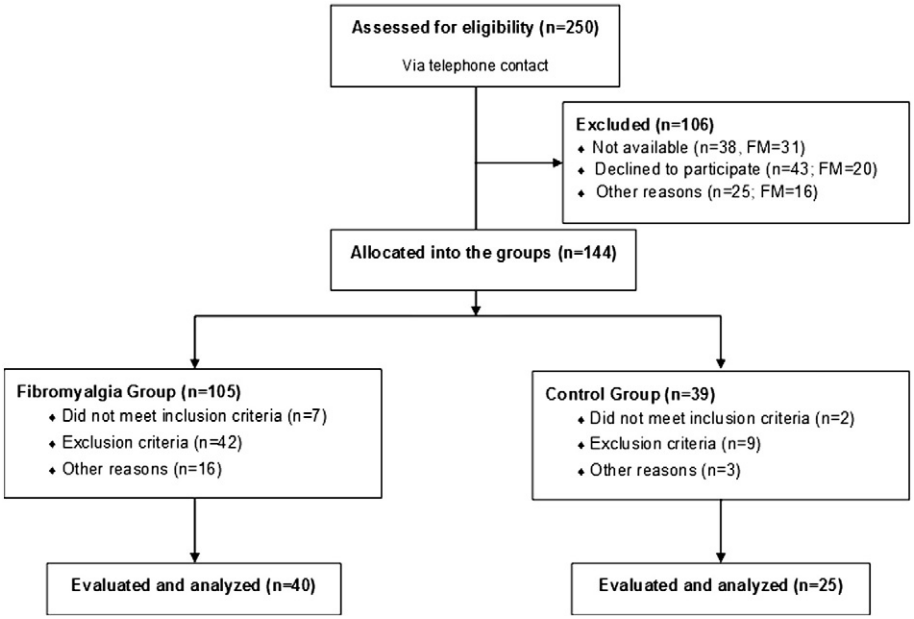

Fig. 1. Flowchart of the study.